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A Resources Use Efficiency Analysis of BT and Non BT Cotton Farmers in Karnataka, India

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1. Introduction:

Cotton (Gossypium sps) the "white gold" and "king of fibers", is cultivated in tropical and subtropical regions of more than seventy countries across the world and enjoys a predominant position amongst all cash crops in India. Cotton contributes 29.90 per cent of the Indian agricultural gross domestic product and provides livelihood to nearly 6 crore people with half of this population employed directly by the textile industry. India occupies first place among cotton growing countries of the world in respect of area (8.8mha), fourth with respect to production (184 lakh bales) during 2006, and in productivity compared to an average yield of 963, 912 and 613 kg/ha in Egypt, USSR and USA, respectively, the India's average yield of cotton is only 440 kg lint/ha (Sen, 2003). This clearly stresses the need for further efforts to increase productivity of the most important commercial crop of the country. In Karnataka, cotton is grown on an area of 3.34 lakh hectares with the production of 4.00 lakh bales and productivity of 204 kg per hectare (Khadi, 2006).

Cotton crop is infested by various pests. Among the pests of cotton, cotton bollworms viz American bollworm (Helicoverpa armigera), Pink bollworm (Pectinophora gossypiella) and spotted bollworms (Earias vitella) cause significant yield losses. About 10 per cent of insecticides on global basis and 45per cent in India is used for control of insects in cotton crop alone (Singh, 2004). The desperate situation faced by cotton farmers due to pest damage and the consequent suicides by many of the cotton farmers led to search for solutions. Application of biotechnology for developing pest resistance in cotton is one among them that appears to hold promise. Bt cotton was released for commercial cultivation in 2002 in India. However, several apprehensions were raised against this technology by farmers' organizations, environmentalists, NGOs and other stakeholders (Qayuam etal, 2003). Clearly there

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has been a fair amount of confusion in drawing inferences on benefits and or losses from Bt cotton (Hugar etal, 2007). Therefore, the present attempt made to find out the resource use efficiency between BTand non BT cotton and also to decompose the difference in output into the contributing factors like technology and difference in input use.

2. Material and methods

The present study was carried out in Karnataka state of southern India during 2007. Data pertaining to the crop year 2006-07 were collected from the selected farmers. Two stage simple random sampling procedure was adopted for the study. Haveri district was selected from the twenty nine districts in Karnataka state, India as it was the major Bt cotton growing area. Four villages in Haveri district were selected in the first stage and in the second stage 80 farmers were selected, consisting of 40 farmers each cultivating Bt and non-Bt cotton respectively.

2.1 Resources use efficiency in cotton cultivation – Cobb-Douglas production function

The resource use efficiency in cotton cultivation under Bt and non-Bt cottons was studied by fitting following Cobb-Douglas type of production function per acre.

$$Y = aX_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6} U \quad \ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where,

Y = Gross returns from Bt cotton / non-Bt cotton (Rs/farm)
a = Intercept, a scale parameter
X_1 = Land under cultivation of Bt cotton /non Bt cotton (acres)
X_2 = Seeds (Rs/ farm)
X_3 = Expenditure on farmyard manure (Rs/farm)
X_4 = Chemical fertilizers (Rs/farm)
X_5 = Expenditure on plant protection chemicals (Rs/farm)
X_6 = Human and Machine labour (Rs/farm)
U = Error term
bi = Output elasticities of respective inputs and summation of these give returns to scale

The equation (1) upon logarithmic transformation takes the linear forms and the parameters were estimated using the Ordinary Least Square (OLS) technique.

$$LnY=Lna+b_1LnX_1+b_2LnX_2+b_3LnX_3+b_4LnX_4+b_5LnX_5+b_6LnX_6+U \ldots\ldots\ldots\ldots \quad (2)$$

Adjusted R^2, the coefficient of adjusted multiple determination was computed to test the goodness of fit of the model. The estimated values of regression coefficients were tested for statistical significance using‘t’ test with chosen level of significance.

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2.2 Decomposition Analysis

The output decomposition model developed by Bisaliah (1977) was used for investigating the percentage change in the gross returns between Bt and non-Bt cotton farming and the factor contributes to the changes by estimates separate production functions. The logarithmic forms of the models fitted were.

$$LnY_1 = Lna_1 + \sum_{i=1}^{6} b_{1i} LnX_{1i} + U_1 \qquad \text{.........................(3)}$$

$$LnY_2 = Lna_2 + \sum_{i=1}^{6} b_{2i} LnX_{2i} + U_2 \qquad \text{.............................(4)}$$

Where,
Y_1 = Gross returns of non-Bt cotton
Y_2 = Gross returns of Bt cotton

Subscripts 1 and 2 in the above equations represent Non-Bt and Bt cotton farming respectively. a_j represents the intercept of j^{th} farm, b_{ji} represents the output elasticities of i^{th} input on j^{th} farm. The variables are defined in the same way as in equation (1).

The decomposition model for analyzing the contribution of inputs to the gross returns was derived by subtracting equation (3) from equation (4) as follows;

$$LnY_2 - LnY_1 = (Lna_2 - Lna_1) + \sum_{i=1}^{7} (b_{2i} LnX_{2i} - b_{1i} LnX_{1i}) + (U_2 - U_1) \qquad \text{..................... (5)}$$

Adding and subtracting $\sum_{i=1}^{6} b_{2i} LnX_{1i}$ in the above equation and rearranging the terms the following decomposition model is arrived at;

$$LnY_2 - LnY_1 = (Lna_2 - Lna_1) + \sum_{i=1}^{6} (b_{2i} - b_{1i}) LnX_{1i} + \sum_{i=1}^{6} b_{2i} (LnX_{2i} - LnX_{1i}) + (U_2 - U_1) \qquad \text{.......... (6)}$$

On application of logarithmic rule, the equation (6) becomes

$$Ln\frac{Y_2}{Y_1} = Ln\frac{a_2}{a_1} + \sum_{i=1}^{6} (b_{2i} - b_{1i}) LnX_{1i} + \sum_{i=1}^{6} b_{2i}\, Ln\frac{X_{2i}}{X_{1i}} + (U_2 - U_1) \qquad \text{..............................(7)}$$

The left hand side of the equation (7) can be considered an approximate measure of percentage change in gross returns from Bt cotton farming over non Bt cotton farming. The additive terms on the right hand side can be interpreted as contributing factors to the change.

The first expression on the right hand side of the equation (7) represents contribution of non-neutral technology (Bt cotton) to change in gross returns while the second and third terms represent the contribution of input use efficiency and level of input use respectively.

3. Results and discussion

3.1 Regression estimates of the Cobb-Douglas type of production function

The per farm gross returns from BT cotton and non-BT cotton during the crop year 2006-07 was regressed to identify the contribution of factors like land, seeds, farm yard manure, plant protection chemicals, human and machine labour. The regression estimates of both BT and non-BT cotton farming are presented in Table 1.

Table1: Regression co-efficient of BT and non-BT cotton farming

Sl. No.	Variables	Regression co-efficient	
		Bt Cotton	Non Bt Cotton
1	Intercept	6.758	8.673
2	Land (acre)	0.679* (0.204)	0.711* (0.274)
3	Seeds (Rs)	0.067 (0.092)	-0.022 (0.040)
4	Farm Yard Manure (Rs)	-0.189 (0.153)	0.119 (0.249)
5	Fertilizers (Rs)	0.077*** (0.059)	-0.159** (0.097)
6	Plant Protection Chemicals (Rs)	-0.146** (0.049)	0.072 (0.069)
7	Labour (Rs)	0.466** (0.144)	0.247** (0.100)
	R^2	0.968	0.975
	$\sum bi$	0.956	0.968

Note: Figures in the parentheses indicate standard errors of the regression co-efficient.
* Significant at 1 per cent
** Significant at 5 per cent
*** Significant at 10 per cent

The co-efficient of adjusted multiple regression was 0.96 and 0.97 for BT and non-BT cotton farming respectively indicating adequate fit of the model as nearly 97 per cent variability in gross returns was explained by the variables considered in the model. The intercept, which represents the contribution of the factors that are not included in the model, was found to be higher in the case of non-BT cotton farmer's field (8.67) compared to BT cotton farming (6.58). The regression co-efficient of land (0.67) in the Bt cotton farming was significant at 1 per cent confidence level while that of plant protection chemicals (-0.146) and labour (0.466) were significant at 5 per cent confident level. The negative significant plant protection chemicals indicating higher use of plant protection chemicals. Whereas positive significant of land and labour, suggesting that an increase in area and labour, would lead to a significant increase in the gross returns in BT cotton. The regression co-efficient of fertilizer (0.0779) was significant at 10 per cent confident level while that of other factors were not statistically significant. However, the co-efficient of seeds was positive while that of the farm yard manure was negative.

In case of non-BT cotton the regression co-efficient of land was (0.711) positive and significant at 1 per cent level. Whereas that fertilizer (-0.159) and labour (0.247) were significant at 5 per cent confidence level. The other co-efficients i.e seeds, farm yard manure and plant protection chemicals in non-Bt cotton were not significant. However, the co-efficients farm yard manure and plant protection chemicals were positive where as that of seeds was negative.

3.2 Geometric mean values of gross returns and inputs used

Table 2: Geometric mean values of inputs and Gross returns in Bt and non-BT cotton farming

Variables	Bt cotton	Non Bt cotton
Gross Returns (Rs)	38982.92	22437.01
land (acre)	2.38	2.05
Seeds (Rs)	2315.78	550.23
Farm Yard Manure (Rs)	1109.84	1800.80
Fertilizer (Rs)	3073.03	2186.33
Plant Protection Chemicals (Rs)	875.22	2336.05
Labour (Rs)	7376.26	5619.79

The geometric mean level of the gross returns was huge in Bt cotton Rs.38982.92 while that of non-Bt cotton was Rs.22437.01 this is mainly due to higher yield. Similar results were observed by Ismael et al (2001) in South Africa. Where farmers adopting Bt cotton had benefited from the technology and because of higher yield and reduction in pesticide cost which had out weighted the higher seed cost. The geometric mean levels of inputs viz., land, seeds, fertilizers and labour in case of Bt cotton (2.38 acre, Rs.2315.78, Rs.3073.03, and Rs.7376.2 respectively) were higher than those of the Non Bt cotton farming (2.05 acre, Rs.550.23, Rs.2186.33, and Rs.5619.79 respectively). Whereas farm yard manure and plant protection chemicals were higher in case of non-Bt cotton (Rs.1800.80 and Rs.2336.05respectively) compared to Bt cotton (Rs.1109.84 and Rs.875.22 respectively) (Table 2).

3.3 Factor contribution to productivity difference between Bt and non-Bt cotton

Decomposition analysis was used to analyse the share of contributing factors to the net change in gross returns from Bt cotton farming over that of non-Bt cotton farming. Table 3 shows that the net measured change in gross returns between Bt cotton and non Bt cotton farming using decomposition analysis was 55.01 per cent. Of this, the total contribution from quantity of input use and its efficiency was 80.39 per cent (56.56 and 23.83 respectively). The contribution of non-neutral technology was negative (-25.3 %). The negative contribution of non-neutral technology indicated that non-BT cotton farmers enjoyed an advantage over BT cotton farmers with respect to production factors not includes in the model. Bisaliah (1977) studying wheat production technology in Punjab reported that improved technology contributed 15 per cent of the total change in output while 25.5 per cent was contributed by increased use of inputs, land, seeds, fertilizers and labour contributed positively to the net change in gross returns (7.84, 65.79, 184.83, and 200.75 per cent respectively).While farm yard manure and plant protection chemicals contributed negatively (-222.73 and -156.06 respectively). This is a clear indication that even the comparatively very low use of plant protection chemicals for Bt cotton was not actually necessary. The highest positive contribution to the net change was from the efficient use of labour (189.08). While the highest negative contribution was due to the inefficiency in the use of farm yard manure (-231.88) in BT cotton farming as compared to non BT cotton farming. The factor contributing least to the difference in returns in case of BT cotton farming was by land (10.13% and -2.29 % respectively due to change in area and inefficiency in use totalling to 7.84 %). The net change in case of plant protection chemicals was a negative (-156.06%) due to change in quantity and inefficiency in use (13.33% and -169.39 % respectively).

Table 3: Contribution of factors to difference in gross returns from BT and non BT cotton farming

Particulars	**% Change attributed to**		**Net % change**
	Quantity used	**Efficiency**	
I. Measured change in gross returns			55.01
II. Sources of change			
A. Non- neutral technology			-25.38
B. Input use			
i) land (acre)	10.13	-2.29	7.84
ii) Seeds	9.63	56.16	65.79
iii) Farm Yard Manure	9.15	-231.88	-222.73
iv) Fertilizers	2.65	182.17	184.83
v) Plant Protection Chemicals	13.33	-169.39	-156.06
vi) Labour	11.67	189.08	200.75
Total	56.56	23.83	80.39

4. Conclusion

The study has measured the efficiency of resource use and share of contributing factors to the net change in gross returns from BT cotton farming over that of non-Bt cotton farming in Karnataka, India. The results revealed that the efficient use of labour, fertilizers and seeds had contributed the most to the difference in returns between BT-cotton and non-BT cotton cultivation. Whereas the productivity difference between BT and Non BT cotton was largely attributed to BT technology. It is also a clear evident that by adopting BT cotton technology the farmers are benefitted significantly. Therefore BT cotton area needs to be expanded among cotton growers to get benefit from this technology in terms of higher productivity and income.

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